

Approved by:

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## 1 **SCOPE**

The purpose of this document is to detail the use of the Lam AutoEtch 490 Plasma Etch System for the etching of silicon nitride and poly-silicon films. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

## 2 **REFERENCE DOCUMENTS**

Lam AutoEtch 490 Plasma Etch System Operations and Maintenance Manual

## 3 **DEFINITIONS**

n/a

## 4 **TOOLS AND MATERIALS**

### 4.1 **General Description**

- 4.1.1 The AutoEtch 490 is a fully automated system, etching single wafers using a plasma dry etch process. It is intended for use etching silicon nitride and poly-silicon thin films. It should not be used to etch oxide films. As a plasma etcher (not an RIE), the minimum linewidths and spaces that can be patterned are approximately 2 microns. It also employs an optical end point detection system to ensure accurate and complete etching of the intended film.

### 4.2 **Wafer Boats**

- 4.2.1 The Lam 490 uses the black polypropylene cassettes. The cassettes are dedicated to the system and should not be removed from the tool.

## 5 SAFETY PRECAUTIONS

### 5.1 Personal Safety Hazards

- 5.1.1 In the event of an emergency such as fire, gas alarm or any other serious problems, push the black **OFF** switch. Immediately evacuate the area and notify a lab staff member or your lab instructor.
- 5.1.2 The etch processes use sulfur hexafluoride SF<sub>6</sub>, Carbon Tetrafluoride CF<sub>4</sub>, Helium He, and oxygen O<sub>2</sub>. These gases are nontoxic but may act as simple asphyxiants (SF<sub>6</sub>, CF<sub>4</sub>, He) or accelerate combustion (O<sub>2</sub>). Read material safety data sheets (MSDS) and be familiar with hazards and safety controls to prevent an accident before using the system.
- 5.1.3 The etcher uses high voltage RF power, which can result in burns or electrical shocks. Never operate the tool with the covers off.
- 5.1.4 The etcher uses pneumatic mechanical drive to actuate the load-lock doors and wafer handling arms. These devices may move quickly and with great force. Do not insert objects (such as tweezers or fingers) into the etcher for any reason, such as recovery of a dropped or broken wafer.

### 5.2 Hazards to the Tool

- 5.2.1 Contaminants- Wafers containing gold, copper or similar metals should not be introduced into the Lam 490 system to prevent cross-contamination of other wafers. Aluminum or tantalum metals are acceptable. Photoresist should be well cured to prevent organic contamination of the system. The back side of wafers should be clean to prevent contamination of the transfer belts or wafer chuck.
- 5.2.2 Pinch Hazards- The Lam 490 Auto Etch has doors on the entrance and exit loadlocks to admit wafers to the system. These doors can close with tremendous force to be able to resist the forces of atmospheric pressure. Attempting to remove jammed or broken wafers with tweezers or fingers may result in the doors pinching the foreign object, resulting in damage to the vacuum seals.

## 6 INSTRUCTIONS

### 6.1 Startup

- 6.1.1 Swipe in on the Card Swipe System, fill out a yellow "Equipment In Use" notice, place it on the tool and fill out a log sheet for the tool on the computer in Metallization I.
- 6.1.2 Turn on **Lam 490 N<sub>2</sub> Purge** and the **Lam 490 Chiller** Nitrogen in service chase behind tool. (Nitrogen Manifold 2705).
- 6.1.3 Verify that the process gases are turned on in the service chase (you should **NOT** turn these off when finished).
- 6.1.4 Check for proper fill on Chiller: Look into site glass on top of unit to make sure that DI water level is within ½" of top. If not use 1gallon DI Water jug supplied at chiller to refill.
- 6.1.5 Turn on the pumps in the service chase behind the Lam Etcher. There is a stack with two pumps on it. On the right front of this stack, make sure that the two switches are on, and that green button has been pressed. Behind these two pumps is a smaller pump. Use the toggle switch on the back to turn this on.
- 6.1.6 On the front panel of the Lam 490, make sure that the power switch is **on**.
- 6.1.7 Two computers, a local computer and a remote computer, control the Lam 490. The remote computer has an external keyboard and monitor (the floppy keyboard) and is used to load recipes into the system and to display data capture (i.e. end point signals). The local computer is positioned within the tool itself and is used for all other functions—starting a process, editing a recipe, etc.

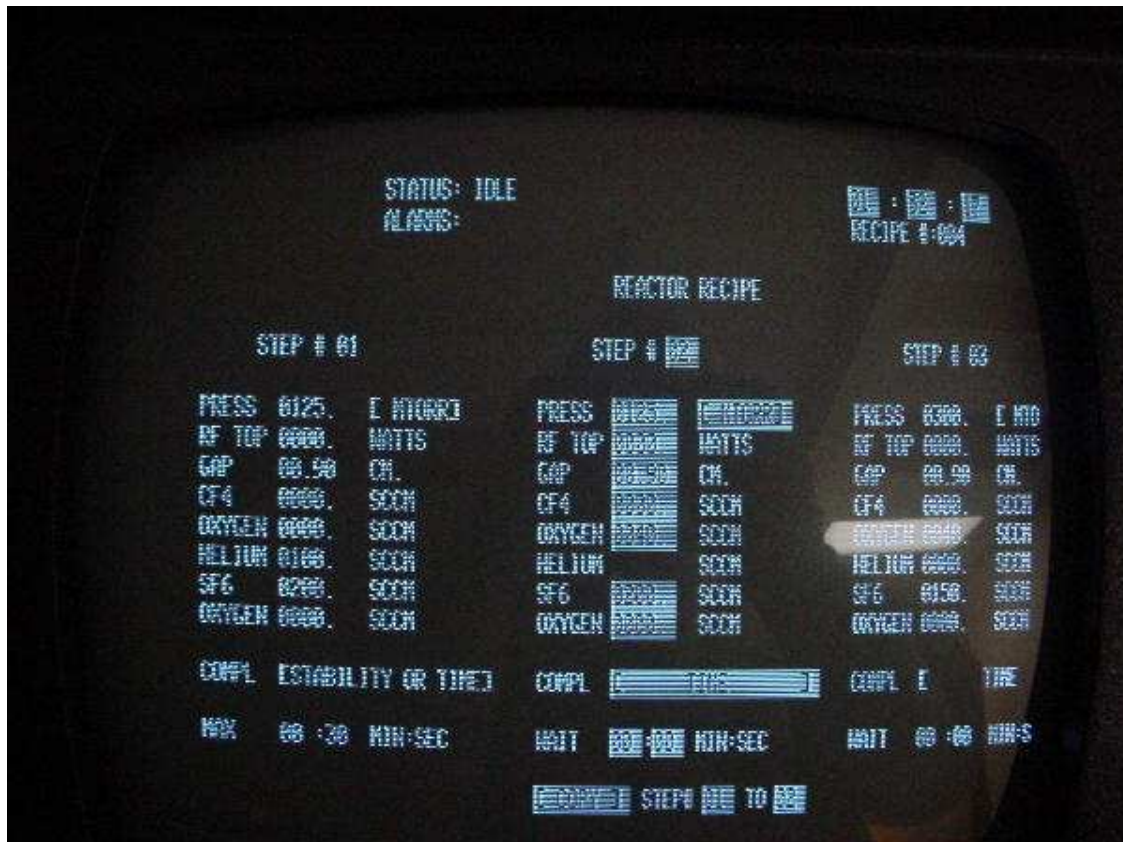
## 6.2 Starting the system

- 6.2.1 When not in use the system is in a standby state. The local computer screen will be dark. Pressing any button on the local keyboard will “wake up” the system.



### 6.3 Select Recipe

- 6.3.1 If the Microsoft Windows screen is up on the remote computer, use the remote keyboard and mouse to click on the **Lam Control** icon to start.
- 6.3.2 If Windows is not up, the **Lam Control** software is already running. Hit the “Escape” key on the remote keyboard several times to return to the main menu.
- 6.3.3 Press ESC to exit the plotting screen on the remote monitor and open the main menu.
- 6.3.4 Choose #6 **Send Rec.**
- 6.3.5 Enter the number of the desired recipe and press RETURN. If you don’t see the recipe you want, you may need to look in a different recipe directory. Type “0” to change the recipe path, and choose a new directory of recipes.
- 6.3.6 After typing “0”, you may select the SMFL directory for the standard recipes.
- 6.3.7 Pressing **RECIPE** on local keyboard will display the loaded recipe for review. Use the four arrow cursor keys to move around from one step to another.



## 6.3.8 Editing a recipe

6.3.8.1 Using the arrow keys, move the cursor to the field that you want to edit.

6.3.8.2 Using the keypad, make the appropriate changes.

6.3.8.3 The recipes in the SMFL directory are the standard for etching 4" and 6" nitride and polysilicon films.

6.3.8.4 These recipes may be shortened and used to find an etch rate for a particular film. This etch rate can then be used to create a timed etch which is useful because the endpoint detection is not always reliable.

#### 6.4 Load Wafers

- 6.4.1 Place wafers in black cassette and place on load elevator.
- 6.4.2 Make sure that the wafer flats are towards the bottom of the cassette. This will help prevent wafers from falling off of the transfer arms.
- 6.4.3 Use the metal wafer holders for etching 4" wafers. **The flats on these should be towards the bottom of the cassette.** Carefully seat the wafer in the holder. Some of the wafer holders are warped and will cause uniformity problems so be sure to use a flat one.
- 6.4.4 Ensure a cassette is placed on the exit elevator.

#### 6.5 End Point Signal

- 6.5.4 The end point signal can be monitored in real time on the remote monitor during an etch process (as well as other inputs—r. f. power, pressure, etc.) if so desired. It is not required to display the end point signal on the remote monitor; the end point will signal the computer to stop the etch without plotting the signal on the screen. To set up the end point real time data capture:
  - 6.5.1 On the remote keyboard and monitor, select **#2 PLOT** from the main menu and then **#2 Variables**.
  - 6.5.2 Select **#9 BLOCK\_1 INPUTS**.
  - 6.5.3 Select desired channel from end point step. The two optical endpoint signals are Channel 12: Input A, 520 nm; and Channel 13: Input B, 405 nm. Select **C for Channel 12** and **D for Channel 13**. It is also possible to plot other analog signals such as pressure or reflected RF power.
  - 6.5.4 Select axis on which to plot data (left or right axis can be chosen).
  - 6.5.5 Repeat the channel and axis selection until you have selected all of the analog signals you wish to plot.
  - 6.5.6 Select **#0 No More Plot Variables** when finished.

6.5.7 Select **#1 SCALE**.

6.5.8 Enter scale value for selected axis. (Min and Max for x axis, left axis and right axis)  
Press ENTER to toggle through scale values and select default. Do not make an entry for a scale which is not being used (press ENTER). If the maximum signal value is not known from a previous etch, use the default value of 0 to 2200.

6.5.9 Select **#3 PLOTTING**.

6.5.10 Select **#2 AUTO COLLECT**.

6.5.11 The remote monitor will now automatically begin capturing the end point signal once the r.f. power is turned on. If more than one wafer is being etched, the plot does not reset after the first wafer. The plot continues to capture additional end point signal in running time on a single plot. If you record the PASS NUMBER from the bottom of the screen, you can recover the analog signal data from the hard disk once the etch is finished, and import the data into Excel or another analysis program.

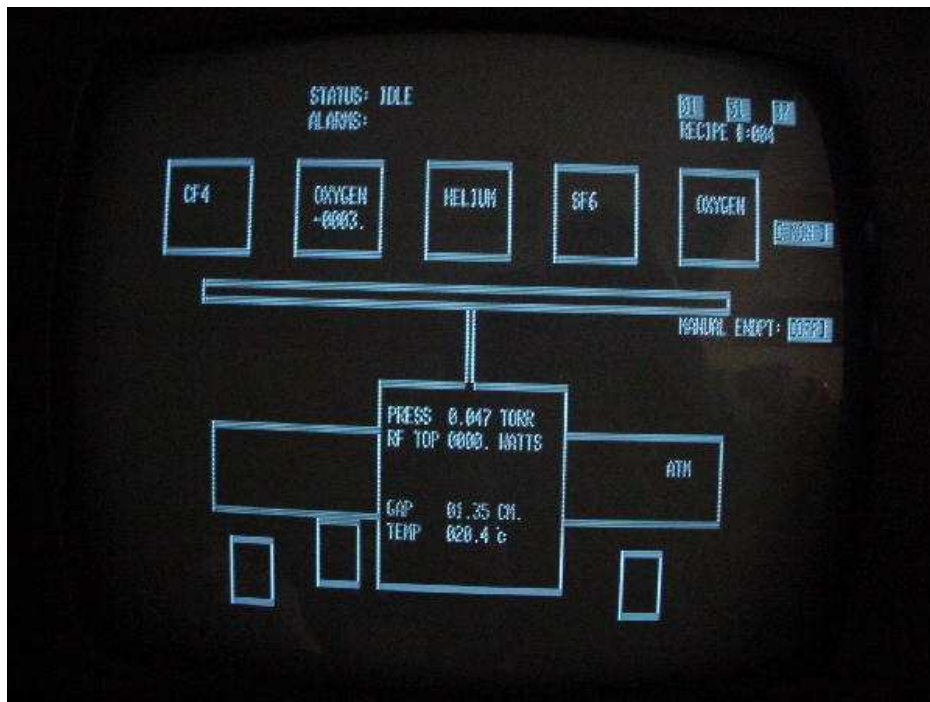
6.5.12 Recovering the graph from your run with the PASS NUMBER

- 6.5.12.1 Escape to main menu
- 6.5.12.2 Select **7 Quit**
- 6.5.12.3 In the Windows Program Manager minimize the screen.
- 6.5.12.4 Open Excel
- 6.5.12.5 Select File.
- 6.5.12.6 Select Open.
- 6.5.12.7 Double click C directory.
- 6.5.12.8 Scroll down to **Prostra** and double click to open.
- 6.5.12.9 Choose **All Files** under file type.
- 6.5.12.10 Find your **Pass #** and double click to open.
- 6.5.12.11 Follow the directions in Excel to view the file.



## 6.6 Start Process

- 6.6.1 Press **START** on the local keyboard. Wafers will process automatically to the exit cassette.
- 6.6.2 Press **STATUS** on local keyboard to monitor the wafer status. The blinking “W” indicates the current location of the wafer.
- 6.6.3 Once a wafer has started etching, it may be stopped by moving the cursor to the Manual Endpoint field and using the [field select] key to turn on the manual endpoint.



## 6.7 End Process

- 6.7.1 The exit elevator will not index to the top when the wafers are completed. Remove exit cassette when wafers are finished. If you put a new entrance cassette on before the etcher returns to IDLE mode, these wafers will be processed using the same recipe. So, BE CAREFUL: If you load your wafers before the last set is *completely* finished, your wafers may start etching with the wrong recipe!

- 6.7.2 Turn off **Lam 490 N<sub>2</sub> Purge** in service chase behind tool. (Nitrogen Manifold 2705)
- 6.7.3 Turn off the pumps in the service chase behind the Lam Etcher. There is a stack with two pumps on it. On the right front of this stack, make sure that red button has been pressed. Behind these two pumps is a smaller pump. Use the toggle switch on the back to turn this off.
- 6.7.4 Remember to swipe out.

## 6.8 Resetting the System

- 6.8.1 If the system needs to be reset, contact the tool technician.

## 6.9 Errors during the Run

- 6.9.1 If transfer belts come off or break contact a staff member.
- 6.9.2 A wafer may become off-centered or fall off of the transfer arm. If this occurs, it is best to immediately turn off the machine power on the front panel. This may prevent wafer breakage and additional tool downtime.
- 6.9.3 Process errors- Occasionally an alarm will sound and an error message will be displayed.
  - 6.9.3.1 From the main menu screen, using the keypad, press the **parameters** button.
  - 6.9.3.2 In the [parameters] field, use the [field select ] key to select [machine]
  - 6.9.3.3 On the machine parameters page, use the arrow keys to move the cursor to the [alarm silent] field. Use the **field select** key to activate.
  - 6.9.3.4 Call an SMFL staff member for further assistance.
- 6.9.4 Input or output doors may hang up. Wait for them to close. (This may take several minutes)
- 6.9.5 If the machine has been off for a while, the Master Module may need to be reloaded. Put the module in the slot, turn on the machine power and press **load**.
- 6.9.6 If you cannot send a recipe from the computer to the etcher, the Lamlink Communication may need to be reset.

- 6.9.6.1 Press the **parameters** key.
- 6.9.6.2 Use the arrow keys to move up to the [machine] field.
- 6.9.6.3 Hit the **field select** key until you get to the [Lamlink] page.
- 6.9.6.4 Use the arrow keys to move down to the Lamlink Mode field.
- 6.9.6.5 Use the **field select** key to change from [inactive] to [active].
- 6.9.6.6 Use the arrow keys to go back to [Lamlink] and press the **field select** key until you get back to [machine] in the parameters screen.
- 6.9.6.7 Hit the **status** key to go back to the main page.

## 7 Appropriate Uses of the Tool

- 7.1 Wafers containing gold, copper or similar metals should not be introduced into the Lam 490 system to prevent cross-contamination of other wafers. Aluminum or tantalum metals are acceptable. Photoresist should be well cured to prevent organic contamination of the system.
- 7.2 This etcher is intended for etching silicon nitride and poly-silicon thin films. It should not be used to etch oxide films. As a plasma etcher (not an RIE), the minimum linewidths and spaces that can be patterned are approximately 2 microns.

## REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	Peterson	A -04/12/2002
Modified service chase set up and added section on appropriate uses of the tool.	O'Brien	B - 10/09/2002
Added section 6.9.5 and 6.9.6./changed 6.1.3 to remove N2/added section 6.7.3	O'Brien	C - 01/08/2003
Clarified 6.1, 6.3, 6.4, 6.6	O'Brien	D - 08/19/2003
Modified section 6.8	O'Brien	E - 02/10/2009